Goddard Safety & Mission Assurance

Vision and Results

Supply Chain 2016

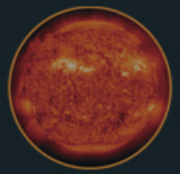
Our vision is to safely reduce the risk of exploring Earth and Space to achieve 100% mission success.

Rich Barney, Deputy Director
Safety and Mission Assurance Directorate
October 25-27, 2016

NASA Goddard SPACE FLIGHT CENTER
www.nasa.gov/goddard

Presentation Flow

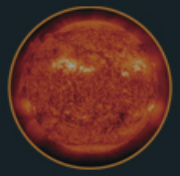
- SMA Organization-Working the Vision
- Risk-Our Backbone
- Results and Stories
  1. Pressure Vessel Systems
  2. Commodities Risk Assessment Engineering
  3. Non Conformances in PCB Coupons
  4. Mission Operations Assurance Integrated Approach
  5. Assurance Systems
  6. Meta
  7. Launch Stories

Why did we reorganize?

- Center Director asked us to define what the “right” type of SMA organization for Goddard should look like.
- We recognized that the current org structure was the result of piece part changes over several years rather than a strategic look at SMA at Goddard.

- We had become overly reliant on requirements without a current rationale for many of them.



- We often focused on eliminating the possibility of undesired events without linking them to credible risks or fully assessing unintended consequences.

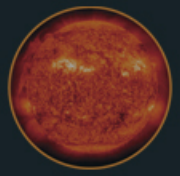
- We have been reactive rather than proactive in the areas of quality and reliability, resulting in catching problems late that could have been predicted early with proper assessment.

- We did not have a rigorous closed loop center-wide quality engineering program.

Vision of the *"right"* SMA Organization

- SMA functions are managed in Code 300 and aligned to OSMA programs.

- Strong technically competent workforce provides *value* added SMA leadership and support. We want to be a *discriminator*….



- Characterizing risk for varying mission classifications and approaches to project implementation is standard practice.

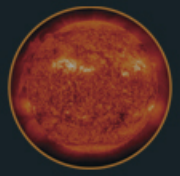
- Technical Authority is well defined for Project Chief Safety and Mission Assurance Officers as well as technical assurance disciplines.

- Clear career paths are proactively managed to develop SMA professionals.

SMA Mission

Reduce the risk of exploring Earth and Space by providing a highly respected Safety and Mission Assurance workforce, who continuously characterizes risk, judiciously applies requirements, and conveys lessons learned to achieve 100% mission success.

- Improve the center's ability to keep people, facilities, and operations safe



- Enable a more proactive and preventive approach to avoid issues that impact mission implementation

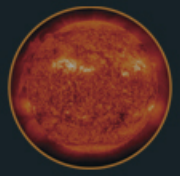
- Identify, communicate, and mitigate risk efficiently and effectively to assure mission success

- Balance Safety and Mission Assurance functions within a constrained resource environment

SMA Directorate Scope

- An independent organization that reports to the Deputy Center Director and provides the SMA Technical Authority function.

- Focuses on mission success through continuous risk management- identification, characterization, assessment, mitigation, reporting and facilitating risk balancing.

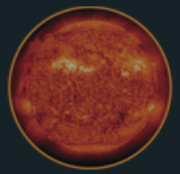


- Has strong Institutional and Project Safety programs that provide a safety focus on our employees, facilities, missions and surroundings.

- Provides leadership throughout the project lifecycle including the implementation of NASA independent reviews.

- Assures that lessons are captured and learned from past decisions, analyses, and experiences.

SMA Directorate-Code 300

Safety & Mission Assurance Directorate
Director: *Judy Bruner*
Deputy Director: *Richard Barney*
Associate Director: *Eric Isaac*
Associate Director: *Michael Kelly*
Associate Director at WFF: *Bob Savage*
Chief Engineer: *Jesse Leitner*
300

Administrative Officer: *Jeanine Doherty*
IT Manager: *Sanjeev Sharma*
Directory Secretary: *Teresa Harkins*
Deputy Directory Secretary: *Darlene Denson*

Directorate Resources Management Office
Directorate Resources Manager: *Curtis Johnson*
300.1

Safety Division
Chief: *Bo Lewis*
Associate Chief, Occupational Safety: *Patrick Hancock*
Associate Chief, Systems Safety: *Roman Kilgore*
Secretary: *Tiana Travers*
360

Quality and Reliability Division
Chief: *Jeannette Plante*
Associate Chief: *Maria Nowak*
Chief Engineer: Mike Viens
NEPP Program: *Michael Sampson*
Workmanship Program: *Jeannette Plante*
Metrology/Calibration Program: *Felicia Donnell*
Project Support Specialist: *Amanda Galaydick*
370

Assurance Systems Division
Chief: *Gaspare Maggio*
Associate Chief: *Robert Sticka*
Standards Program: *Josef Wonsever*
New Business Coordinator: *Joe Hall*
Project Support Specialist: *Katie Lind*
380

Reliability & Risk Assessment Branch
Branch Head: *Nancy Lindsey*
371

Mission Software & Ground Systems Assurance Branch
Branch Head: *Susan Sekira*
372

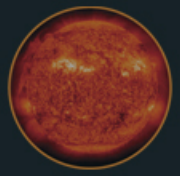
Quality Engineering Branch
Branch Head: *Steven Herron*
373

Systems Review Branch
Branch Head: *VACANT*
381

Management Systems Branch
Branch Head: *Cindy Mead*
382

Mission Assurance Branch
Branch Head: *John Rauscher*
Associate Branch Head: *Ron Perison*

Goddard SMA Professionals



Safety Division

- Project Safety Managers
- Project Safety Engineers
- Occupational Safety Managers Occupational Safety Engineers
- Fire Protection Engineers
- Industrial Hygienists
- Health Physicists

Quality and Reliability Division

- Reliability and Maintainability Engineers
- Commodity Risk Assessment Engineers
- Program/Project Managers, Technical Standards Specialist
- Configuration Management Specialists
- Risk Manager
- Ground Systems Assurance Managers
- Software Assurance Engineers
- Mission Operations Assurance Engineers
- Quality Assurance Engineer
- Quality Assurance Specialist
- Workmanship Program Manager
- Parts and Radiation Assurance Engineer
- Materials and Process Assurance Engineer
- Technical Quality Assurance Leads

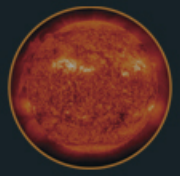
Assurance Systems Division

- Chief Safety and Mission Assurance Officers
- System Review Managers
- Management System Assessors
- Supply Chain Managers
- Information System Specialists
- Program/Project Managers
- Technical Standards Specialist
- Configuration Management Specialists

What is risk?

- There was once a college that offered a class on probability applied to the real world.

- The class was relatively easy, but there was a catch. There were no homework assignments or tests, but there was a final exam that would have only one question on it.



- When everyone received the test it was a blank sheet of paper with a solitary question on it: "What is risk?"

- Most students were able to pass, but only one student received 100% for the class! Even stranger was that he only wrote down one word!

What did he write?

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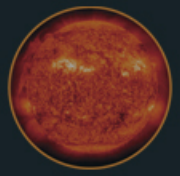

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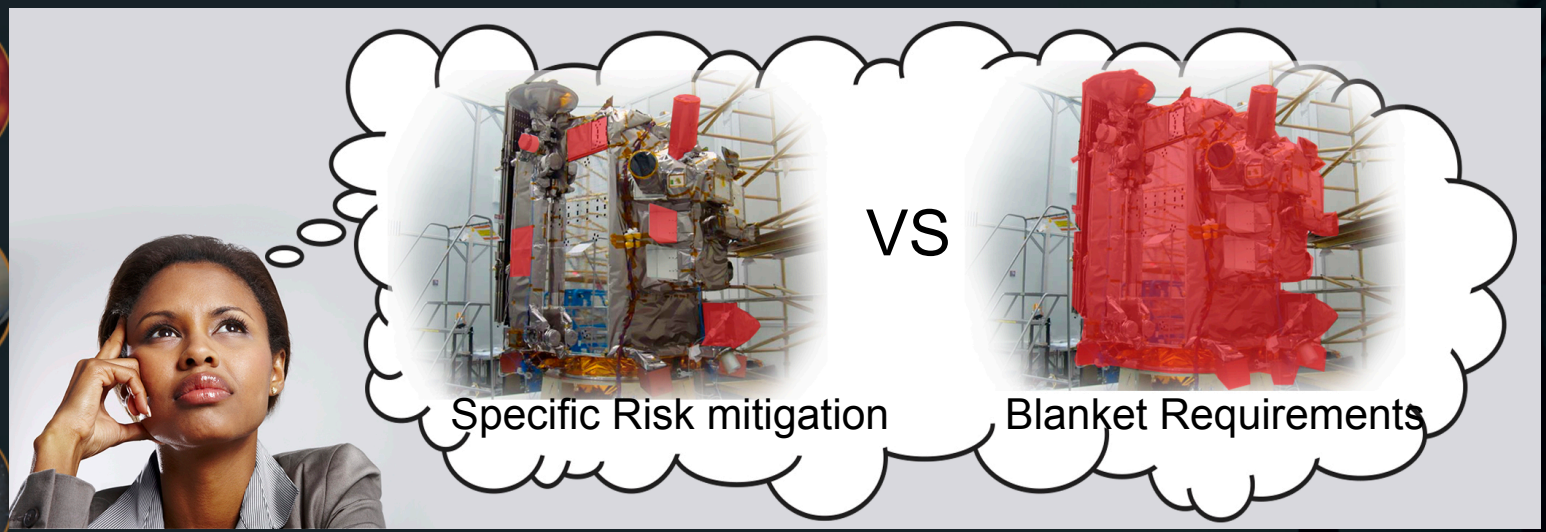
What did he write? "THIS"

Risk as a Common Language

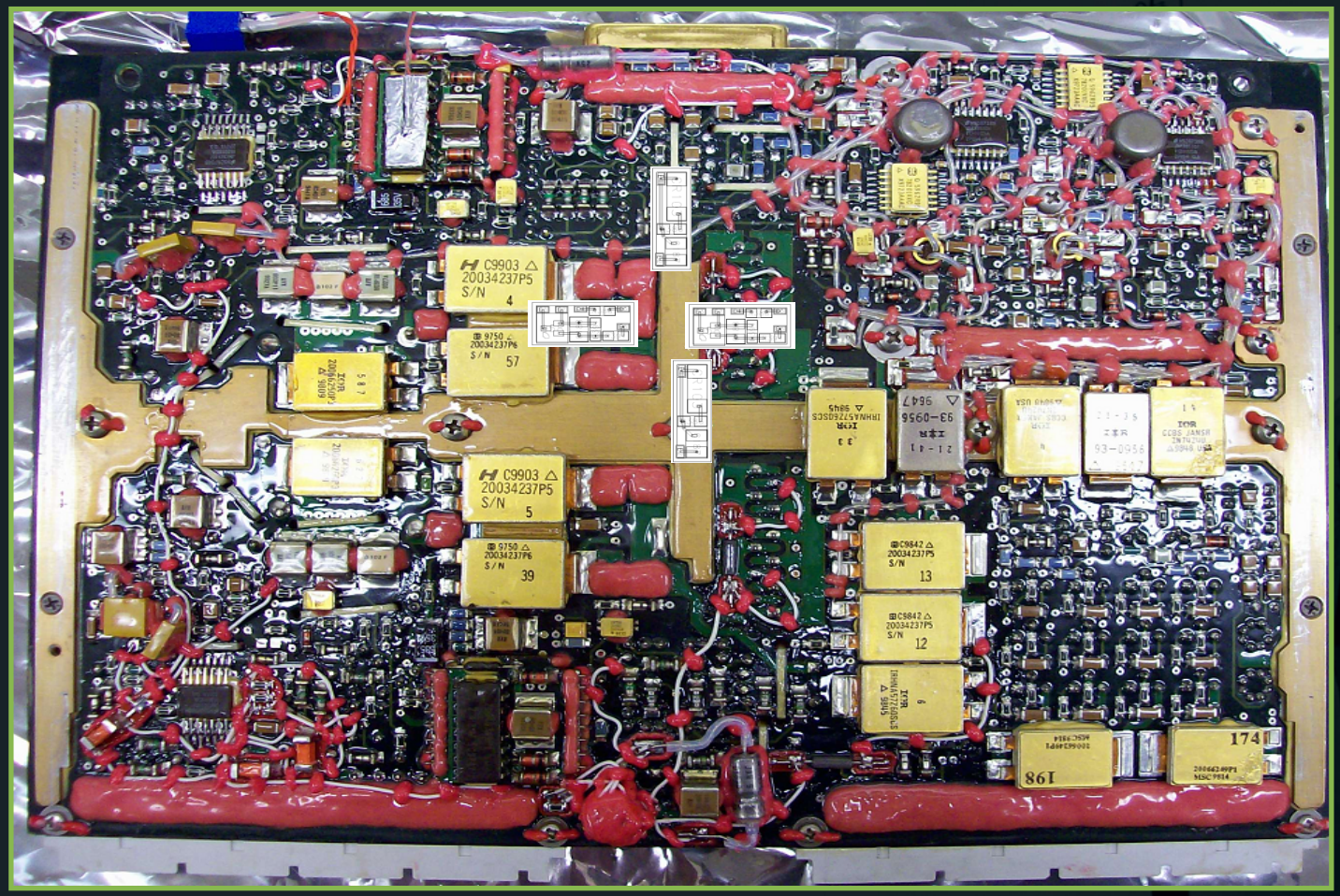
- Risk is the common communication language between all of the technical and nontechnical disciplines in a project

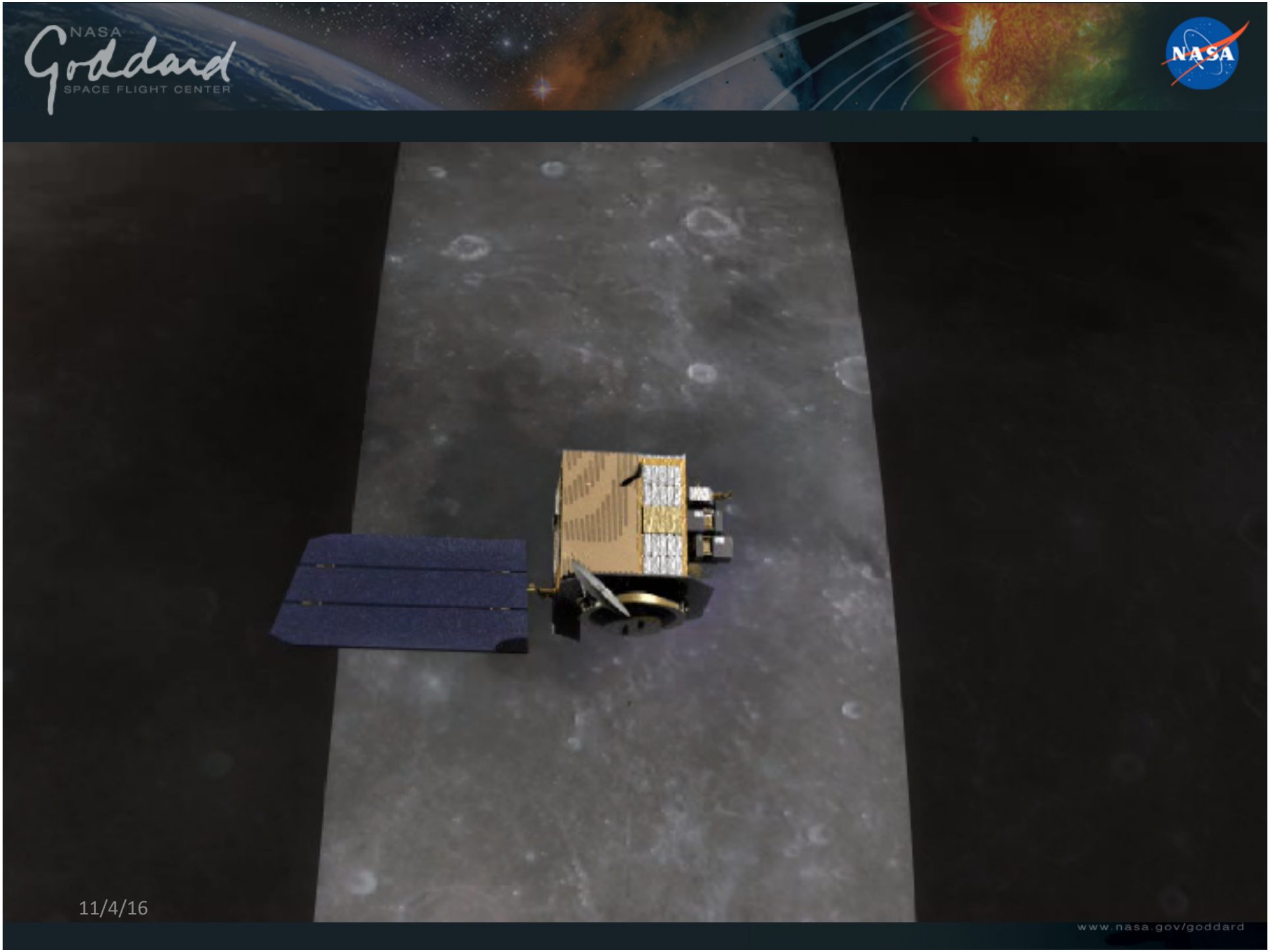
What is Risk-Based SMA?

The process of applying limited resources to maximize the chance for safety & mission success by focusing on mitigating specific risks that are applicable to the project vs. simply enforcing a set of requirements because they have always worked



Ugly vs. Risky—Does Ugliness = Riskiness?

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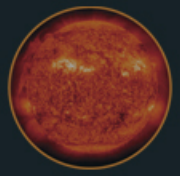
Attributes of risk-based SMA

- Upfront assessment of reliability and risk, e.g. tall poles, to prioritize how resources and requirements will be applied
- Early discussions with developer on their approach for ensuring mission success (e.g., use of high-quality parts for critical items and lower grade parts where design is fault-tolerant)

- Judicious application of requirements based on learning from previous projects and the results from the reliability/risk assessments



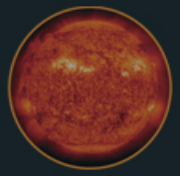
- Characterization of risk for nonconforming items to determine suitability for use – project makes determination whether to accept, not accept, or mitigate risks based on consideration of all risks

- Continuous review of requirements for suitability based on current processes, technologies, and recent experiences.

New Processes Underlie Risk-Based SMA

- Efficient dispositioning of Inherited Items
  - GPR 8730.5

- Definition and guidance across all risk classifications, risk-based SMA practices
  - GPR 8705.4



- Proactive processes and definition of Code 300 roles throughout the lifecycle
  - GPR 8730.10

- Better understanding and relationships with developers/vendors
  - All three directives

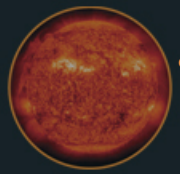
Mission Success Activities vs. Risk Posture

Categories	Class A	Class B	Class C	Class D	Ground System (GS)	7120.8 Class	Do No Harm (DNH)	Hosted Payload Class (host requirements)
Polymeric Applications	Polymerics-A from GSFC workmanship STD	Polymerics-B from GSFC workmanship STD	Polymerics-C from GSFC workmanship STD	Polymerics-D from GSFC workmanship STD	J-STD-001E, Class 3, conformal coating and encapsulation only, tailor **down** for repairs	J-STD-001E, Class 3, conformal coating and encapsulation only, tailor **down** for repairs	J-STD-001E, Class 3, conformal coating and encapsulation only, tailor **down** for repair	n/a
Cable/Harness	Cable/Harness-A from GSFC workmanship STD	Cable/Harness-B from GSFC workmanship STD	Cable/Harness-C from GSFC workmanship STD	Cable/Harness-D from GSFC workmanship STD	IPC/WHMA-A-620B, Class 3	IPC/WHMA-A-620B, Class 1	IPC/WHMA-A-620B, Class 1	
Printed Circuit Boards	GSFC-led design review of all new PCB designs and designs that have not been proven reliable in comparable environment. PCB-A from GSFC PCB STD. Note that flexibility	For cost- plus, GSFC-led design review of all new PCB designs and designs that have not been proven reliable in comparable environment. For fixed price, GSFC participant in	GSFC participant in developer design reviews for all new PCB designs. PCB-C from GSFC PCB STD or PCB-D from GSFC PCB STD. Vendors with significant	GSFC participant in developer design reviews for all new PCB designs. PCB-D from GSFC PCB STD. Vendors with significant GSFC experience	Commercial practice	Visual inspection of boards. Selection of requirements based on criticality and known board and environ-mental attributes (thermal cycles,	Visual inspection of boards.	Host practices

*Excerpt from GPR 8705.4

1. Risk Based Approach to Certifying GSFC Pressure Systems

- Prior to Reorg
  - PVS was located in Code 500; no Code 300 involvement
  - Approach to PVS certification was to certify all GSFC systems in 10 years (by 2021)
  - Even though list of riskiest systems was developed, actual systems being certified were primarily the simple systems
  - PVS & LDE were managed by the same person



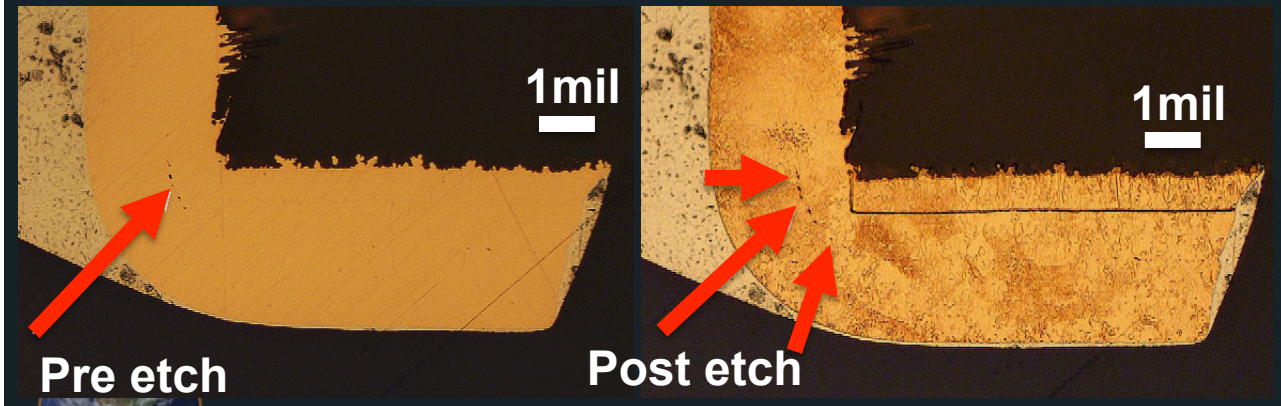
- After Reorg
  - PVS split into independent GB (360) and WFF (803) functions
  - Changed emphasis from # of systems certified/month to using risk based approach
    - Use contractor to certify Steam System and 255 (horizontal thermal vacuum chamber in B7)
    - Train interns to certify simple systems
  - Split PVS and LDE functions and hired PVS Manager to lead effort

2. Creation of Commodity Risk Assessment Engineering (CRAE)

- Leaders of Risk-based approach
- Proactive support to Projects
- Tailored to Project needs, risk
- Technical depth

Past	Now
MAR essentially the same for all Projects	Standard Components CRAE – Leads the Inherited Items Review Process. Tailoring.
SMEs not available for cross-project work. No contingency planning	CRAEs work across projects. CRAE can be made available at a moment's notice
Quick analysis, Quick fixes, Risk Rules more important than Risk Impact	CRAEs are experts in communicating in terms of RISK!
Programmatic risk not understood, lack awareness	Cost and Schedule impacts (Programmatic Risks) as well as Safety/Technical Performance
Lessons are forgotten	Capturing lessons and continual learning

3. Non-conformances in Printed Circuit Board Coupons



GSFC Coupon Lab finds a non-conforming PCB coupon. What should we do?

Past	Now
Code 541 Coupon Lab evaluates PCB micro-sections and determines that boards are non-conforming to IPC specification. Example: Attribute which is non-conforming is PCB plating quality, separation between layers is observed, non-conforming per IPC-6012C 3/A, table 3-9 and section 3.6.2.1.	PCB Commodity Risk Assessment Engineer (PCB CRAE) communicates risk of non-conformances to the Projects.
Laboratory report is provided to GSFC project. Project contacts the Vendor and PCB fabricator for discussion.	PCB CRAE helps in reducing unnecessary PCB respins, and helps the Project better control resources.
Recommendation is made to refabricate and replace entire lots of PCBs, resulting in cost/schedule impacts.	PCB CRAE evaluates the non conformances in the context of actual risk to the project and provides a risk statement.

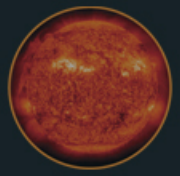
Risk-based PCB solution

- Risk assessments are performed when coupons are nonconforming prior to rebuilding. This was initially implemented as an option, and later as a requirement.
- A central working group performs all of the risk assessments (with specialized support from projects as needed).
- Initial risk assessments took weeks to perform. Now they take hours in most cases.
- Out of the 90 risk assessments, boards from 6 panels were determined to be of elevated risk and scrapped (7% rejection).
- Each risk assessment is associated with one panel and each panel may have several boards (a recent example had 8). Each production run generally costs ~ $5k - $20k and takes between 2-8 weeks.
- **Cost savings of scrapped boards is between $360k and $1.5M, schedule savings is between 140 and 560 weeks. The cost of the process itself is also much lower.**
  - Does not account for frequent re-attempts to build the same board without knowing the cause of the nonconformance or cost of microsection analysis labor.

Continuous improvement and learning are at the core of our new approach.

Risk-based PCB – corrective action

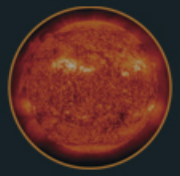
- Some requirements frequently reappear in risk assessments
- Requirements that frequently are violated and rarely entail risk raise red flags and demand continuing actions:
  - Industry survey
  - In-house testing
  - Follow-up with requirements body
- Example: copper wrap requirement in IPC 6012 3/A for buried/hidden vias
  - Frequently violated (especially for European products since requirement not included in European spec)
  - Can be very difficult to achieve
  - Uniformity across the board is ambiguous
  - Prompted a major lien for ICESat-2

Risk-based PCB – corrective action

- Performed three independent lines of testing
  - Thermal cycled the ICESat-2 coupons through 50+equivalent lifetimes
  - Produced multiple board designs with variable levels of thickness for life tests
  - Performed highly stressing interconnecting stress testing until failure

- Performed structural modeling in COMSOL™



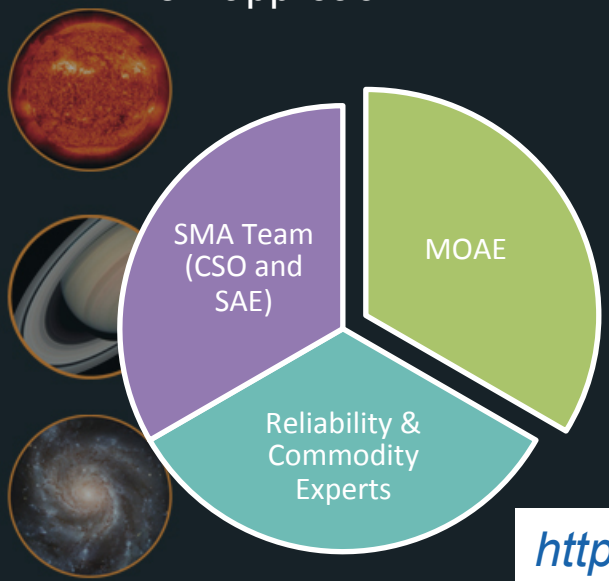
- All testing and modeling concluded that wrap meeting requirement did not improve reliability

- We presented results at Quality Leadership Forum, then circled back to IPC with results

- Formed a committee in IPC to reevaluate the requirement.

4. MOA Integrated Approach

- Mission Operations Assurance is a collaborative effort throughout the project lifecycle
- SMA team members works together to ensure successful transfer of knowledge through project commissioning
- Directives being updated to capture new approach

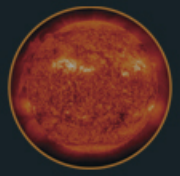


Previous Approach
Activities focused on post-launch support activities with SSMO, ESMO, and HST customer base
Primary responsibilities included anomaly management, data management, and close out activities
Minimal interaction with a project's SMA team
New Approach
Support expanded to include pre and post-launch support
Collaborative effort established between the CSO, SAE, and MOAE to complete the knowledge transfer
Partnership with Reliability and Commodity Experts to identify and research trends, cross-project issues, and potential risks to operational, as well as development projects
Emphasis on reporting trends, lessons learned, and risks to SMA, SMA partners, development projects, and operational teams

https://spaces.gsfc.nasa.gov/display/SMA300/Code+300+Wiki

5. Assurance Systems-new positions, people & direction

- We now have Program CSOs working with all of our Goddard Program Offices; in general these individuals:
  - Work common SMA problems across the program
  - Encourage the use of current SMA best practices and processes
  - Serve as an ambassador of SMA at the program level
  - Provide mentoring for the project CSOs within the program



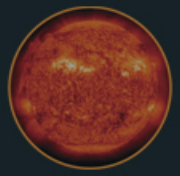
- We now conduct SMA Strategy Sessions before costing out the SMA support for a specific project
  - The purpose of the strategy session is to guide branch estimates and the development of the Mission Assurance Requirements
  - The inputs to the strategy should include data about inherited hardware and available historical data from relevant mission operations

6. Meta – Metamorphosizing SMA

- We continue making great strides in the development and deployment of our Meta Information System

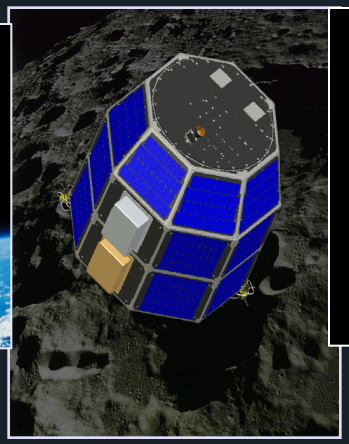
  - We had 485 Users in April 2015; as of today we have 1,200

  - Development of Meta Modules Completed in the last year:
    - Supplier Quality Management Assessments
    - Supply Chain Risk Assessments
    - Supplier Insight
    - Product Inspection Tracking
    - SMA Watch List
    - SMA Risk Management
    - Goddard Review Management (GRMx)
    - Product Inspection Tool

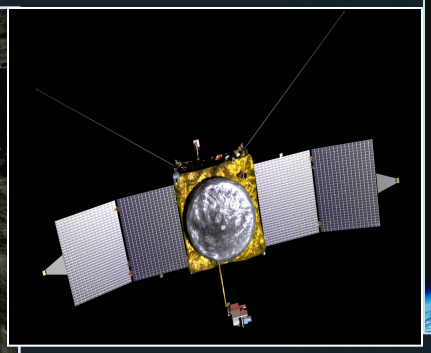



7. Launch Stories

LDCM Launch
February 2013



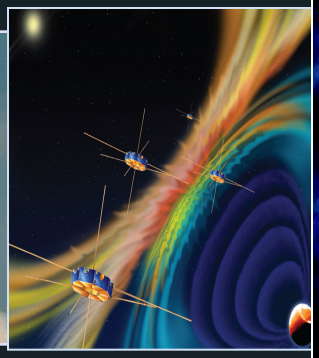
LADEE Launch
Summer 2013



MAVEN Launch
November 2013

GPM Launch
February 2014

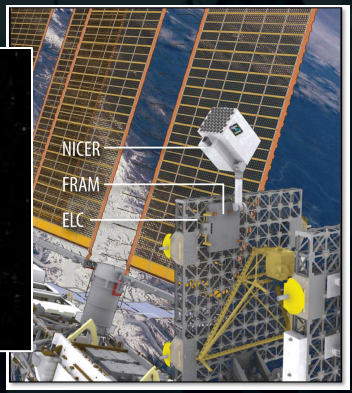
Numerous
Suborbital
Missions



MMS Launch
March 2014

GOES-R Launch
Fall 2016

OSIRIS-Re Launch
Sept. 2016



NICER Launch
Oct. 2016

SMA Contacts

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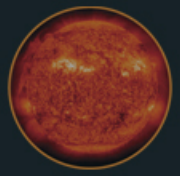

Assurance Systems Division

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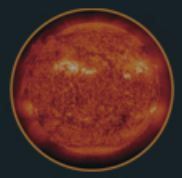

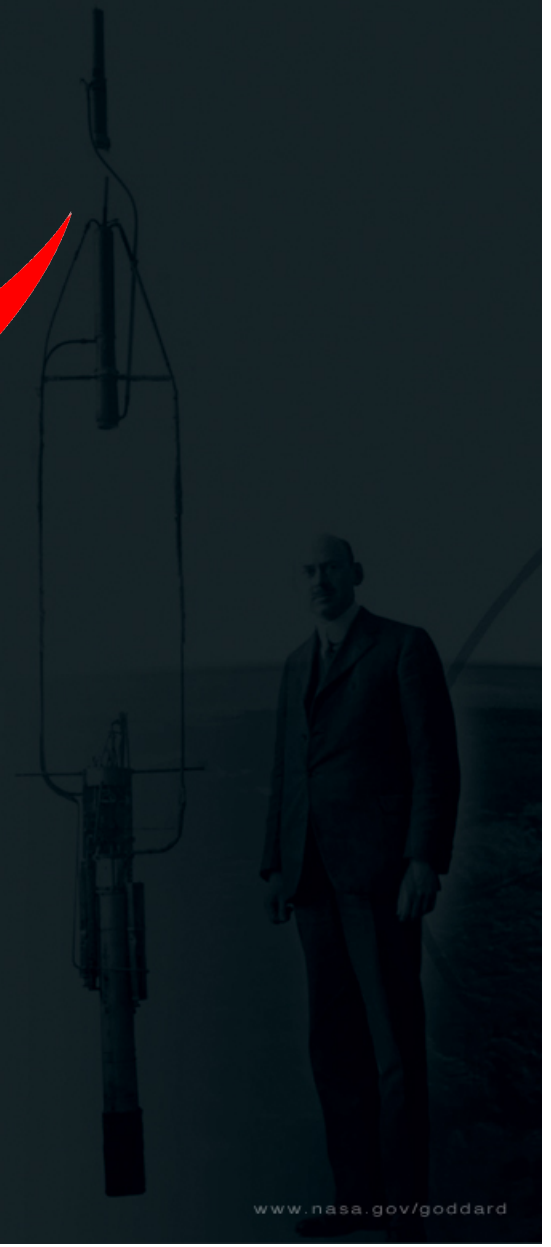

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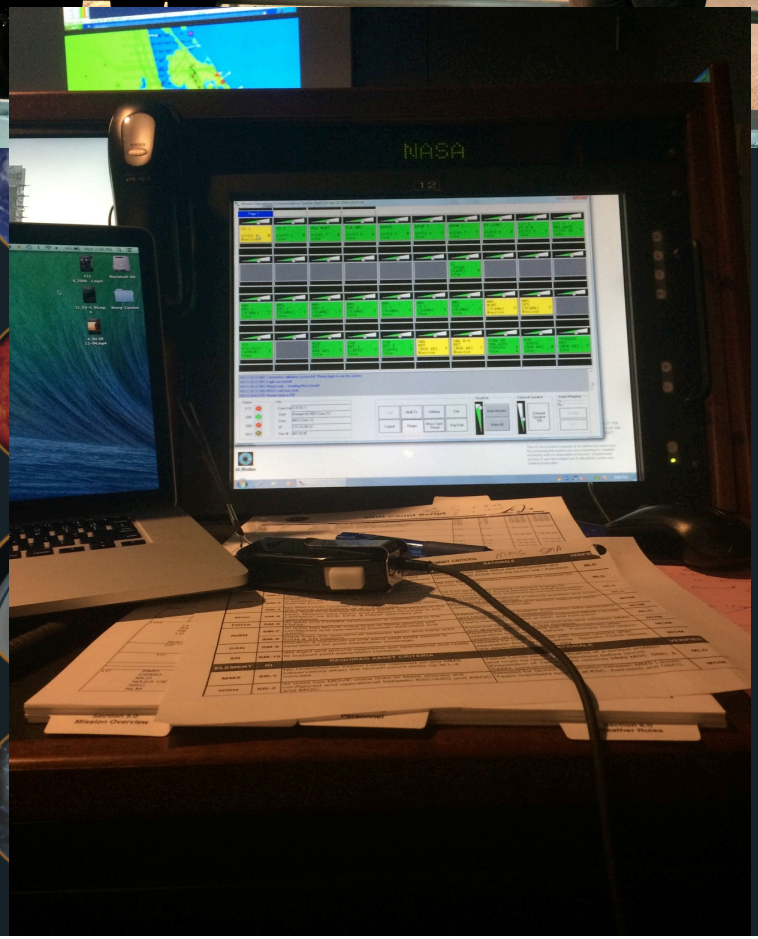
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Osiris-Rex Launch Stories

- On Sept 1, 2016, a SpaceX Falcon 9 rocket and its satellite payload exploded on Pad 41 during a hot fire test.
- Osiris-Rex was on Pad 40 just a mile away being integrated for launch (Sept. 8).
- Nobody was hurt and our pad did not sustain any damage, however, ….